Supplemental figures showing the nature of each signature used in the study:

Table A1. Contains signatures used in the cluster analysis, including USGS gage number, Runoff Ratio (R_{QP}), Baseflow Index (I_{BF}), Slope of the FDC (S_{FDC}), Streamflow Elasticity (E_{QP}), Ratio of Snow Days (R_{SD}), and Rising Limb Density (R_{LD}).

Figure A1. Bar graph of annual totals of precipitation and streamflow of two selected catchments over the decade analyzed. Graph (a) shows the catchment with the lowest value for Runoff Ratio, R_{QP} = 0.02. Graph (b) shows the catchment that has the highest value of R_{QP} (0.69).

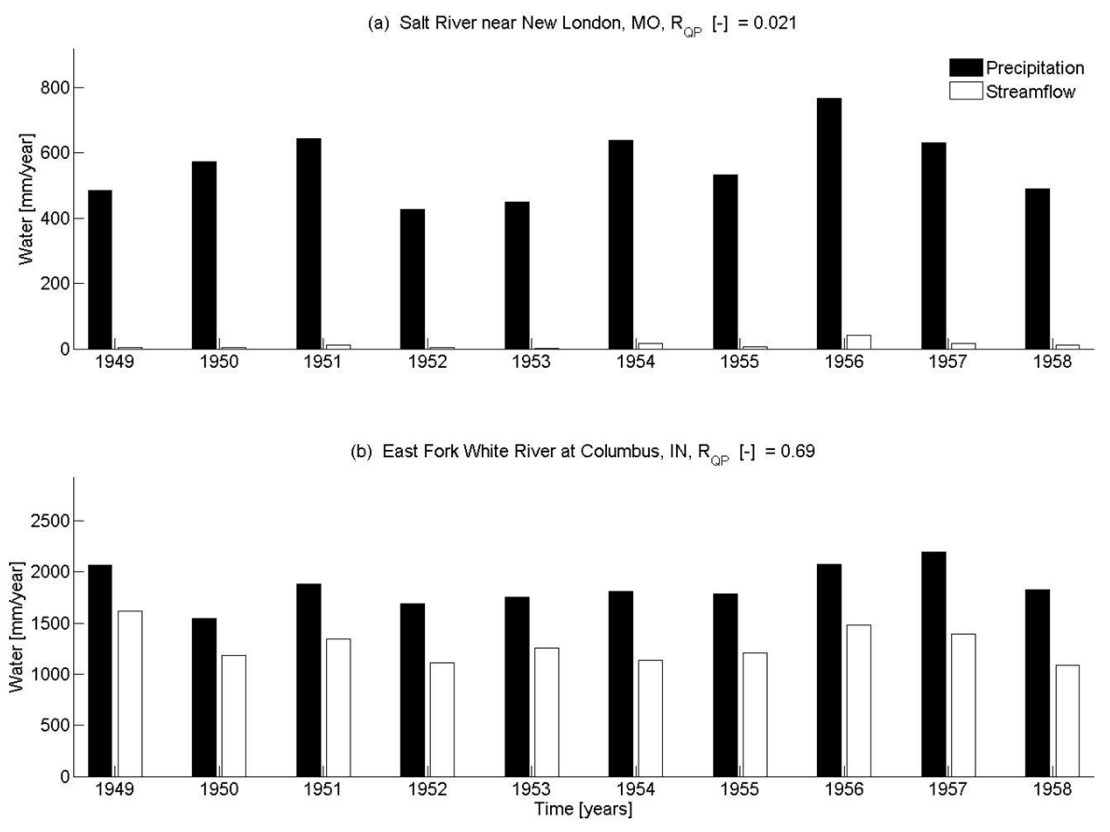
Figure A2. Semi-log plot of flow duration curves of two selected catchments. The vertical axis represents streamflow values normalized by the mean streamflow value of each catchment. Plot (a) shows the catchment with the lowest value for S_{FDC} (0.0087), while plot (b) shows the highest (0.093). Hydrographs of both catchments for example years are shown in plot (c).

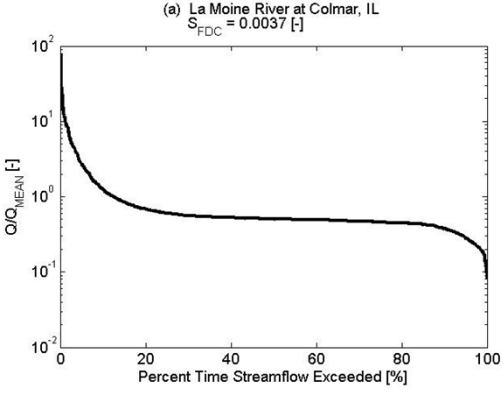
Figure A3. Plot of hydrographs and filer-based baseflow separation for one example year for two selected catchments with very different I_{BF} values. Graph (a) shows the catchment with the lowest value for I_{BF} (0.31), while graph (b) shows the catchment that has the highest value of IBF (0.9) in the dataset used.

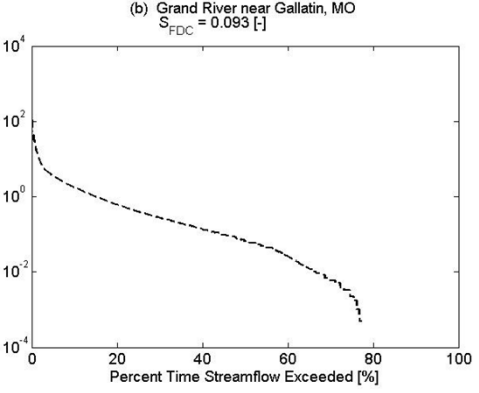
Figure A4. Bar graphs of differences in inter-annual precipitation and in inter-annual streamflow of two selected catchments normalized by mean precipitation and mean streamflow, respectively. Delta Precipitation represents the change in precipitation between two years normalized by the average value of precipitation over those years (using hydrologic rather than calendar years). Delta Streamflow represents the change in precipitation between 2 years normalized by the average value of streamflow over those years. The median value of these ratios, used as estimate of streamflow elasticity, for each catchment is highlighted by a dotted black box.

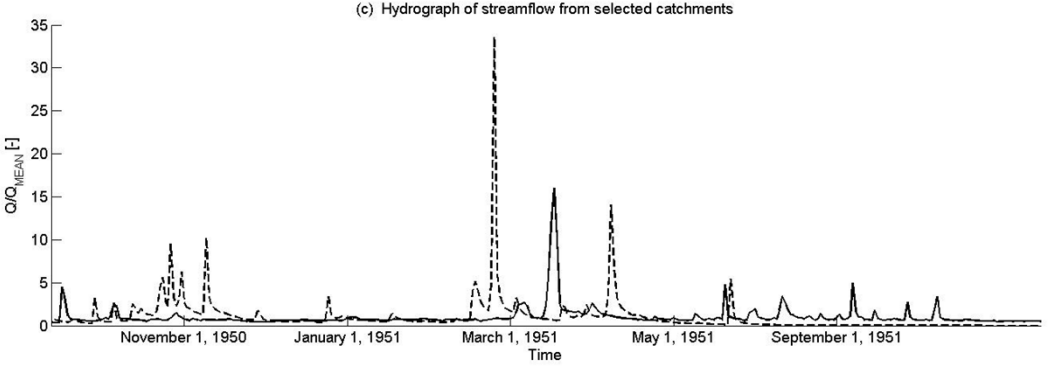
Figure A5. Figure showing plots of precipitation, normalized streamflow and temperature for two catchments of which one has basically no snow storage (a), while the other one shows extensive snow storage (b) throughout much of the year where the temperature is close to zero or even below.

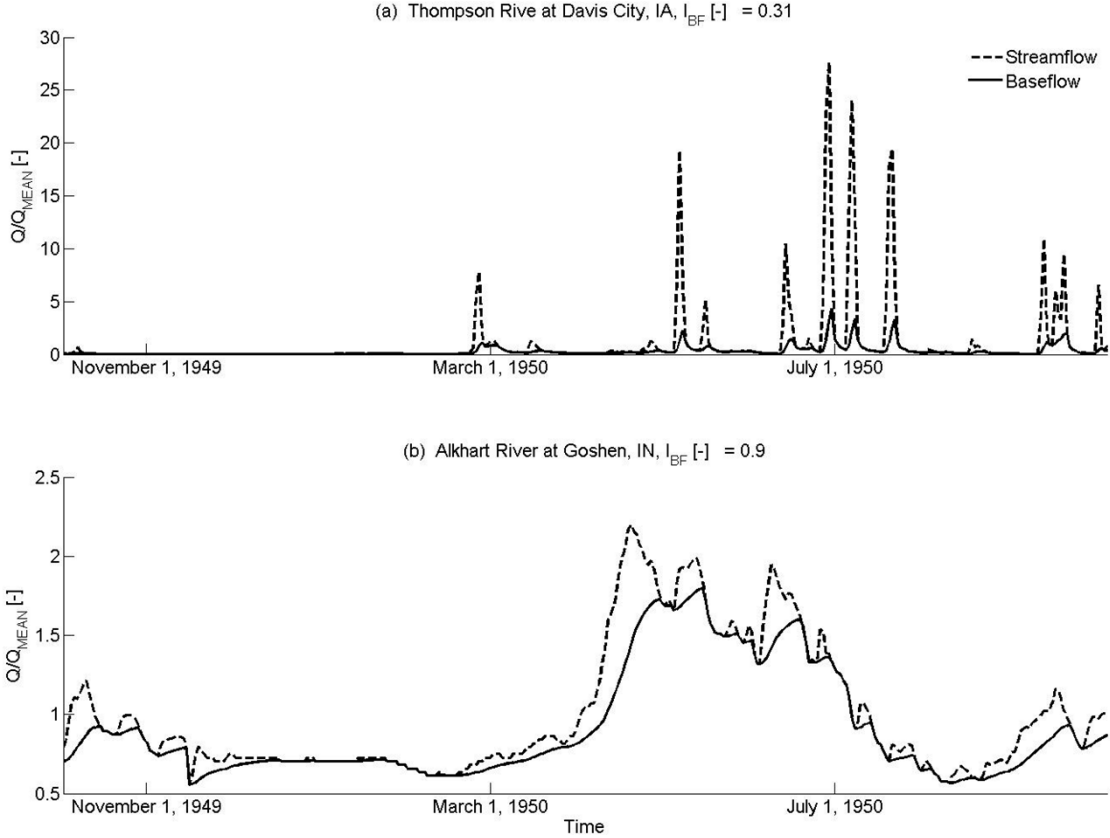
Figure A6. Figure showing plots of precipitation and streamflow for two catchments of which one (a) has the highest R_{LD} (0.65) and very flashy response, while the other (b) has the lowest RLD (0.15) and a very gradual response.

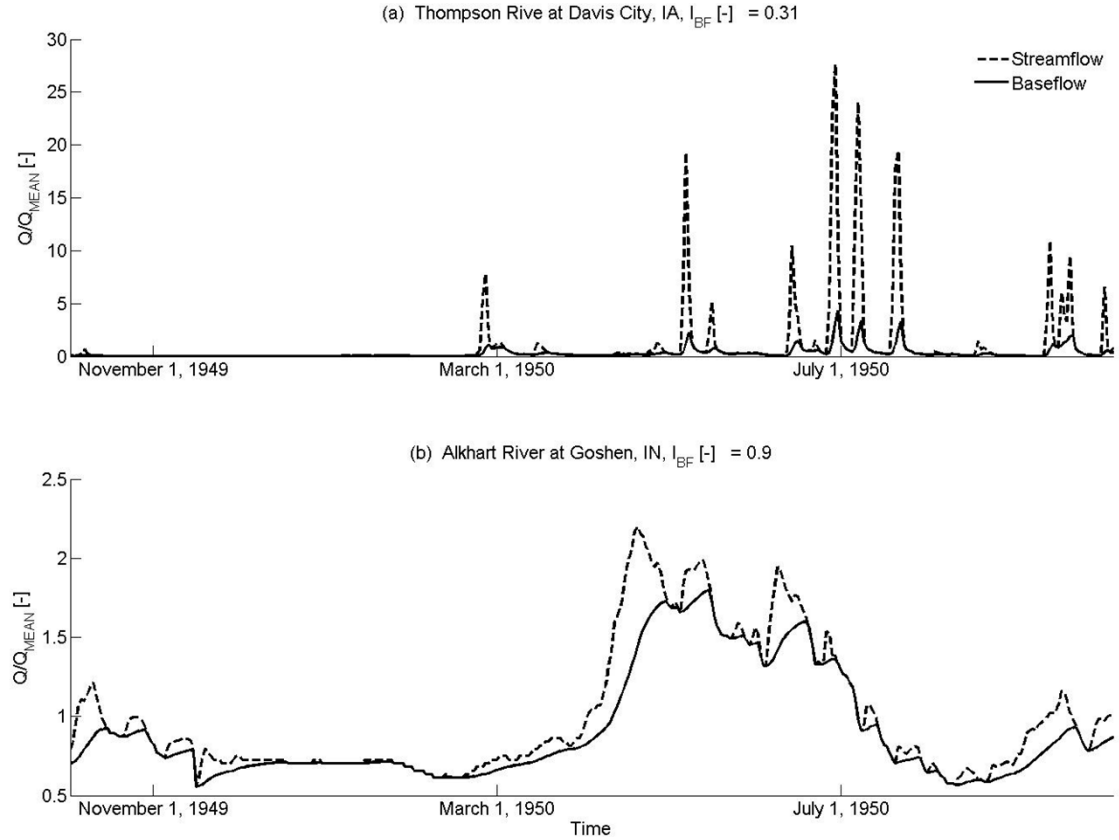

(a) Salt River near New London, MO, R_{QP} [-] = 0.021
Precipitation
Streamflow
Water [mm/year]
800
600
400
200
0
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
(b) East Fork White River at Columbus, IN, R_{QP} [-] = 0.69
Water [mm/year]
2500
2000
1500
1000
500
0
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
Time [years]

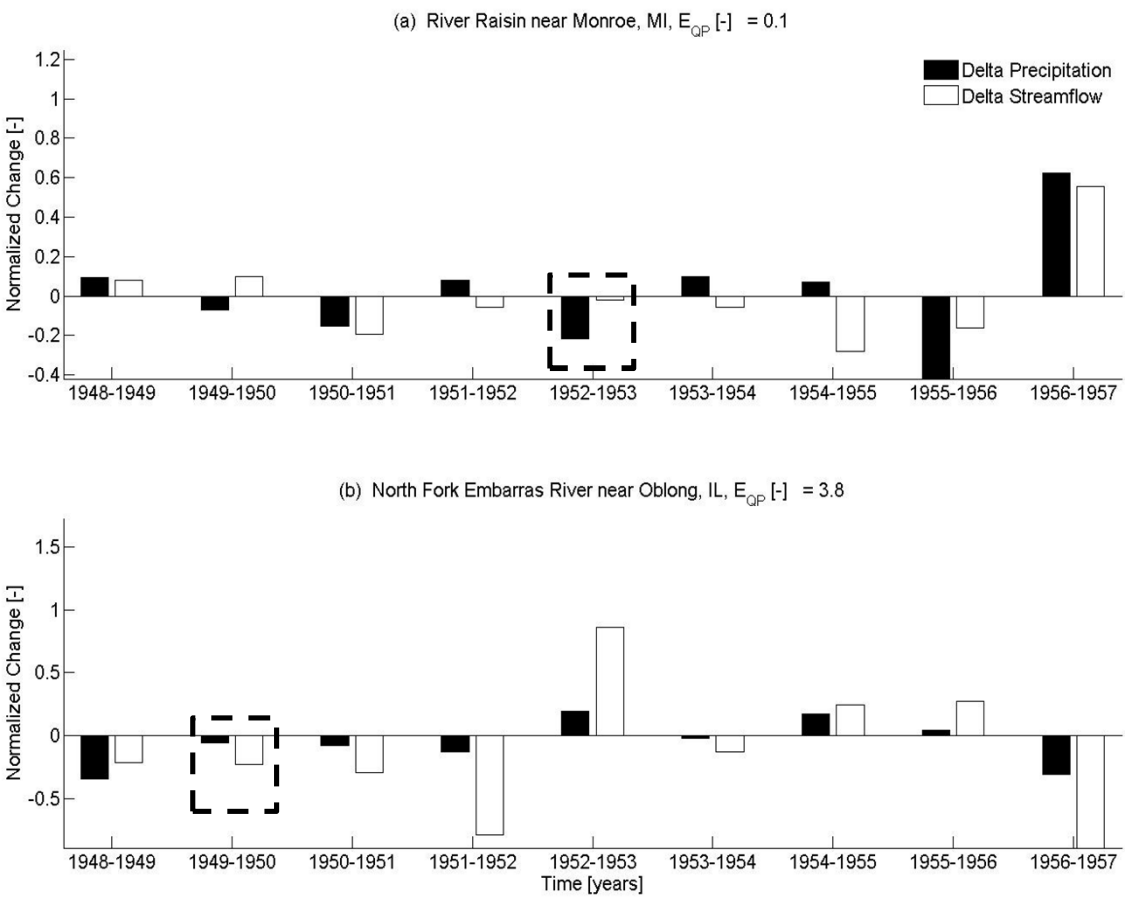

(a) La Moine River at Colmar, IL
S_{FDC} = 0.0037 [-]
Q/Q_{MEAN} [-]
Percent Time Streamflow Exceeded [%]


(b) Grand River near Gallatin, MO
S_{FDC} = 0.093 [-]
Percent Time Streamflow Exceeded [%]


(c) Hydrograph of streamflow from selected catchments
Q/Q_{MEAN} [-]
November 1, 1950
January 1, 1951
March 1, 1951
May 1, 1951
September 1, 1951
Time


(a) Thompson Rive at Davis City, IA, I_{BF} [-] = 0.31
Streamflow
Baseflow
Q/Q_{MEAN} [-]
30
25
20
15
10
5
0
November 1, 1949
March 1, 1950
July 1, 1950
(b) Alkhart River at Goshen, IN, I_{BF} [-] = 0.9
Q/Q_{MEAN} [-]
2.5
2
1.5
1
0.5
November 1, 1949
March 1, 1950
July 1, 1950
Time


(a) Thompson Rive at Davis City, IA, I_{BF} [-] = 0.31
Streamflow
Baseflow
Q/Q_{MEAN} [-]
30
25
20
15
10
5
0
November 1, 1949
March 1, 1950
July 1, 1950
(b) Alkhart River at Goshen, IN, I_{BF} [-] = 0.9
Q/Q_{MEAN} [-]
2.5
2
1.5
1
0.5
November 1, 1949
March 1, 1950
July 1, 1950
Time


(a) River Raisin near Monroe, MI, E_{QP} [-] = 0.1
Delta Precipitation
Delta Streamflow
Normalized Change [-]
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
1948-1949
1949-1950
1950-1951
1951-1952
1952-1953
1953-1954
1954-1955
1955-1956
1956-1957
(b) North Fork Embarras River near Oblong, IL, E_{QP} [-] = 3.8
Normalized Change [-]
1.5
1
0.5
0
-0.5
1948-1949
1949-1950
1950-1951
1951-1952
1952-1953
1953-1954
1954-1955
1955-1956
1956-1957
Time [years]

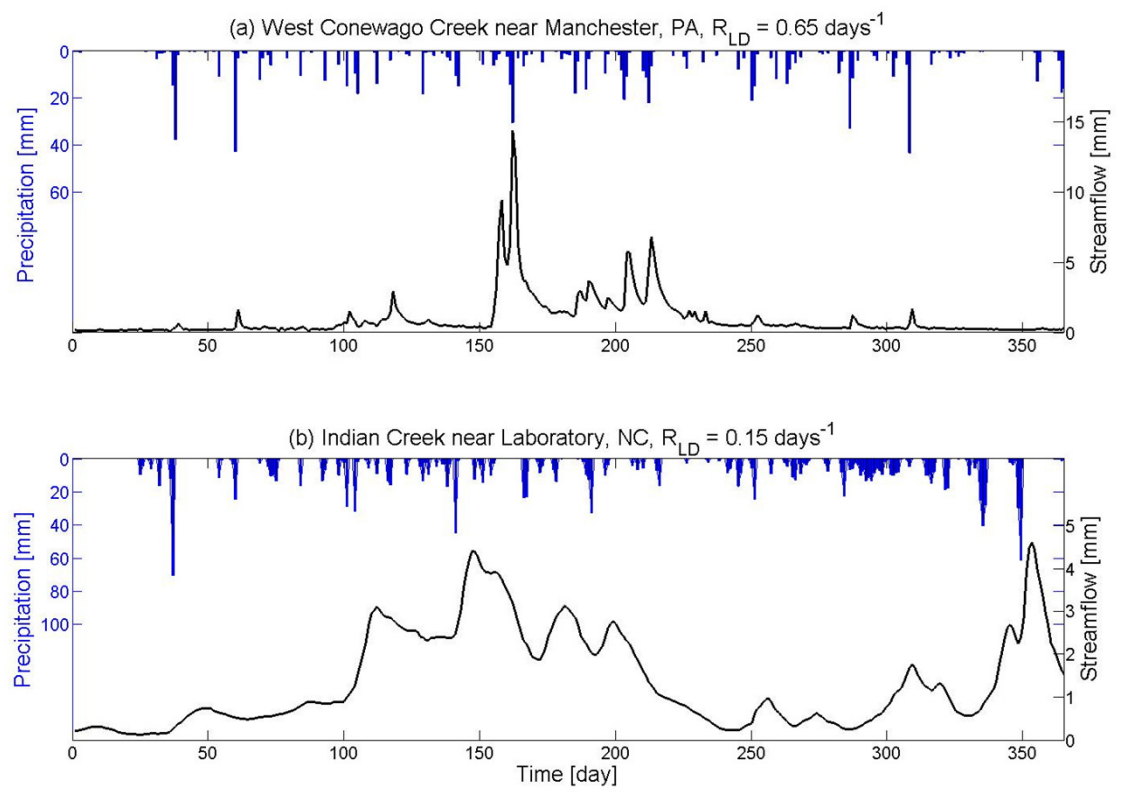

(a) West Conewago Creek near Manchester, PA, R_{LD} = 0.65 days^{-1}
Precipitation [mm]
Streamflow [mm]
0
20
40
60
0
5
10
15
0
50
100
150
200
250
300
350
(b) Indian Creek near Laboratory, NC, R_{LD} = 0.15 days^{-1}
Precipitation [mm]
Streamflow [mm]
0
20
40
60
80
100
0
1
2
3
4
5
0
50
100
150
200
250
300
350
Time [day]

Table A1

Catchment ID	R_{QP}	S_{FDC}	E_{QP}	I_{BF}	R_{SD}	R_{LD}
01055500	0.605	0.030	0.593	0.675	0.396	0.416
01064500	0.676	0.022	0.921	0.696	0.480	0.407
01076500	0.627	0.026	0.916	0.671	0.456	0.499
01127000	0.586	0.031	0.858	0.721	0.320	0.493
01197500	0.553	0.025	1.394	0.703	0.394	0.467
01200000	0.505	0.036	1.470	0.723	0.342	0.502
01321000	0.640	0.030	0.937	0.683	0.464	0.581
01334500	0.535	0.029	1.144	0.716	0.399	0.511
01371500	0.480	0.040	1.841	0.639	0.339	0.525
01372500	0.481	0.044	1.916	0.705	0.340	0.504
01421000	0.554	0.024	1.535	0.688	0.412	0.590
01423000	0.579	0.035	1.213	0.660	0.405	0.494
01426500	0.567	0.034	1.633	0.667	0.403	0.492
01445500	0.425	0.025	1.768	0.781	0.313	0.485
01500500	0.562	0.038	1.638	0.714	0.405	0.510
01503000	0.555	0.036	1.700	0.702	0.401	0.522
01512500	0.567	0.033	1.474	0.699	0.421	0.556
01518000	0.494	0.043	1.355	0.604	0.421	0.574
01520000	0.394	0.053	1.557	0.542	0.417	0.446
01520500	0.425	0.046	1.582	0.576	0.410	0.450
01531000	0.438	0.043	1.254	0.605	0.413	0.550
01534000	0.512	0.038	1.612	0.618	0.393	0.513
01541000	0.570	0.040	1.453	0.617	0.382	0.546
01541500	0.526	0.040	1.755	0.640	0.392	0.486
01543500	0.586	0.043	1.877	0.603	0.415	0.434
01548500	0.543	0.042	2.046	0.638	0.430	0.514
01556000	0.491	0.034	1.199	0.672	0.344	0.532
01558000	0.579	0.032	2.125	0.718	0.369	0.494
01559000	0.470	0.030	2.042	0.715	0.353	0.463
01560000	0.463	0.044	2.891	0.607	0.326	0.496
01562000	0.425	0.039	3.320	0.644	0.320	0.547
01567000	0.438	0.034	2.780	0.693	0.327	0.578
01574000	0.388	0.039	1.866	0.559	0.253	0.650
01595000	0.660	0.038	1.134	0.601	0.350	0.544
01606500	0.382	0.037	1.163	0.661	0.274	0.494
01608500	0.365	0.039	1.682	0.650	0.263	0.538
01610000	0.387	0.038	1.548	0.655	0.282	0.490
01611500	0.324	0.040	1.998	0.606	0.269	0.596
01628500	0.322	0.024	2.148	0.726	0.229	0.467

01631000	0.339	0.025	1.903	0.725	0.231	0.432
01634000	0.281	0.031	2.454	0.688	0.226	0.441
01643000	0.361	0.031	1.427	0.630	0.247	0.435
01649500	0.358	0.022	0.513	0.601	0.172	0.519
01663500	0.368	0.026	1.755	0.690	0.186	0.487
01664000	0.338	0.028	1.737	0.678	0.183	0.461
01667500	0.337	0.027	1.823	0.697	0.166	0.501
01668000	0.315	0.027	1.870	0.656	0.173	0.610
01672500	0.285	0.027	1.579	0.618	0.139	0.530
01674500	0.305	0.027	1.484	0.708	0.129	0.495
02016000	0.378	0.032	1.861	0.627	0.238	0.526
02018000	0.385	0.037	0.303	0.630	0.201	0.450
02030500	0.299	0.023	1.635	0.632	0.123	0.427
02055000	0.302	0.024	0.672	0.694	0.174	0.334
02083500	0.284	0.027	1.141	0.657	0.079	0.454
02102000	0.292	0.030	2.531	0.470	0.068	0.414
02116500	0.343	0.015	1.072	0.743	0.124	0.472
02118000	0.297	0.015	1.235	0.722	0.101	0.493
02135000	0.268	0.022	0.650	0.827	0.042	0.475
02138500	0.508	0.021	0.700	0.689	0.202	0.493
02143040	0.467	0.016	0.188	0.694	0.152	0.467
02143500	0.375	0.020	3.198	0.675	0.078	0.155
02192000	0.286	0.020	0.670	0.702	0.046	0.614
02202500	0.209	0.026	0.824	0.823	0.018	0.642
02217500	0.285	0.020	1.240	0.723	0.044	0.573
02273000	0.210	0.016	0.104	0.918	0.000	0.193
02296750	0.248	0.032	2.433	0.722	0.000	0.464
02329000	0.187	0.040	2.380	0.699	0.010	0.449
02339500	0.324	0.018	0.732	0.740	0.051	0.428
02347500	0.304	0.025	1.966	0.684	0.027	0.168
02349500	0.322	0.019	1.755	0.764	0.023	0.372
02365500	0.342	0.019	0.573	0.757	0.010	0.258
02383500	0.414	0.021	1.516	0.730	0.080	0.411
02387000	0.434	0.035	1.269	0.580	0.074	0.284
02387500	0.414	0.025	1.356	0.667	0.078	0.319
02414500	0.346	0.023	1.733	0.705	0.051	0.394
02448000	0.327	0.047	1.409	0.518	0.039	0.542
02456500	0.365	0.051	1.754	0.589	0.057	0.431
02472000	0.310	0.034	1.655	0.538	0.021	0.449
02475000	0.317	0.028	1.477	0.658	0.018	0.491
02475500	0.284	0.042	1.582	0.501	0.031	0.480
02478500	0.282	0.034	1.812	0.669	0.026	0.459

02479300	0.402	0.025	1.760	0.607	0.025	0.420
02482000	0.292	0.066	1.812	0.627	0.037	0.360
02486000	0.314	0.050	1.872	0.669	0.035	0.458
02492000	0.331	0.015	1.879	0.723	0.011	0.306
03010500	0.594	0.040	1.144	0.647	0.431	0.415
03011020	0.587	0.039	1.126	0.655	0.427	0.379
03020500	0.606	0.032	0.933	0.597	0.413	0.418
03024000	0.605	0.039	0.689	0.625	0.403	0.426
03032500	0.530	0.040	1.087	0.619	0.394	0.458
03050500	0.477	0.041	1.416	0.533	0.307	0.456
03051000	0.501	0.040	1.316	0.540	0.301	0.496
03054500	0.542	0.040	1.307	0.565	0.289	0.366
03065000	0.696	0.036	1.579	0.569	0.325	0.486
03069000	0.671	0.030	1.248	0.590	0.326	0.457
03069500	0.618	0.034	1.204	0.582	0.323	0.467
03070000	0.631	0.036	1.202	0.576	0.319	0.435
03075500	0.647	0.039	1.310	0.594	0.330	0.486
03079000	0.568	0.042	1.397	0.617	0.362	0.469
03109500	0.431	0.040	1.435	0.594	0.332	0.469
03111500	0.361	0.034	1.687	0.692	0.310	0.446
03114500	0.423	0.056	0.909	0.434	0.256	0.544
03155500	0.435	0.060	1.545	0.406	0.246	0.511
03159500	0.359	0.047	1.731	0.589	0.280	0.490
03161000	0.490	0.016	0.842	0.791	0.208	0.578
03164000	0.450	0.018	1.439	0.751	0.207	0.438
03167000	0.380	0.022	3.041	0.708	0.216	0.534
03168000	0.411	0.017	1.498	0.747	0.209	0.459
03173000	0.393	0.032	2.138	0.643	0.214	0.439
03175500	0.454	0.036	1.736	0.640	0.233	0.517
03179000	0.412	0.048	1.755	0.568	0.238	0.447
03180500	0.423	0.040	1.288	0.591	0.336	0.553
03182500	0.439	0.042	1.204	0.567	0.327	0.495
03183500	0.428	0.042	1.415	0.584	0.294	0.558
03184000	0.432	0.042	1.402	0.595	0.289	0.438
03186500	0.657	0.035	1.386	0.567	0.306	0.450
03198500	0.432	0.052	1.487	0.569	0.234	0.433
03237500	0.396	0.052	1.070	0.387	0.228	0.480
03238500	0.380	0.051	1.413	0.323	0.254	0.432
03251500	0.414	0.059	1.096	0.545	0.207	0.404
03252500	0.376	0.063	1.272	0.449	0.202	0.401
03253500	0.391	0.058	1.324	0.534	0.207	0.489
03265000	0.381	0.040	2.113	0.502	0.311	0.459

03266000	0.406	0.039	1.173	0.534	0.304	0.504
03269500	0.387	0.020	1.642	0.743	0.307	0.509
03274000	0.361	0.033	2.033	0.636	0.299	0.446
03281500	0.444	0.060	1.704	0.470	0.175	0.542
03289500	0.420	0.055	1.511	0.548	0.200	0.558
03301500	0.414	0.057	2.614	0.470	0.180	0.399
03303000	0.756	0.044	1.728	0.567	0.201	0.470
03308500	0.469	0.047	3.640	0.547	0.161	0.440
03324300	0.322	0.041	3.542	0.420	0.324	0.491
03326500	0.362	0.039	1.435	0.490	0.321	0.450
03328500	0.443	0.027	1.691	0.649	0.339	0.611
03331500	0.362	0.023	1.462	0.801	0.351	0.510
03339500	0.390	0.034	1.695	0.523	0.285	0.407
03346000	0.288	0.053	3.540	0.369	0.229	0.419
03348000	0.370	0.028	0.872	0.594	0.305	0.484
03349000	0.336	0.032	0.919	0.611	0.303	0.405
03361500	0.386	0.029	1.864	0.622	0.288	0.439
03362500	0.380	0.037	1.945	0.561	0.287	0.525
03363000	0.382	0.034	2.015	0.630	0.283	0.449
03364000	0.386	0.033	2.759	0.629	0.282	0.393
03365500	0.381	0.034	1.892	0.635	0.275	0.487
03410500	0.475	0.051	1.180	0.526	0.162	0.442
03438000	0.448	0.047	3.774	0.619	0.145	0.584
03443000	0.580	0.017	1.360	0.791	0.142	0.470
03451500	0.458	0.017	1.455	0.786	0.149	0.455
03455000	0.384	0.020	0.508	0.755	0.148	0.483
03465500	0.443	0.022	0.334	0.731	0.190	0.426
03473000	0.432	0.028	1.533	0.691	0.204	0.427
03504000	0.687	0.018	1.076	0.800	0.167	0.416
03512000	0.548	0.019	1.812	0.762	0.196	0.330
03524000	0.435	0.036	3.148	0.615	0.211	0.522
03528000	0.431	0.039	2.568	0.629	0.185	0.549
03531500	0.443	0.043	2.106	0.576	0.184	0.512
03532000	0.459	0.040	2.844	0.617	0.170	0.518
03540500	0.501	0.066	1.362	0.534	0.160	0.518
03550000	0.441	0.025	1.137	0.730	0.150	0.527
03574500	0.498	0.058	1.927	0.501	0.084	0.596
04073500	0.345	0.013	0.683	0.870	0.365	0.501
04079000	0.291	0.015	0.759	0.843	0.407	0.438
04100500	0.365	0.020	1.087	0.799	0.367	0.644
04113000	0.303	0.028	2.400	0.739	0.393	0.607
04115000	0.280	0.045	2.091	0.709	0.395	0.536

04165500	0.365	0.028	1.042	0.676	0.389	0.443
04176500	0.300	0.030	2.669	0.661	0.370	0.391
04178000	0.387	0.039	2.343	0.622	0.367	0.480
04185000	0.327	0.043	2.982	0.593	0.364	0.432
04191500	0.328	0.080	0.199	0.438	0.321	0.437
04198000	0.310	0.056	0.020	0.484	0.324	0.618
04201500	0.415	0.051	1.330	0.408	0.363	0.520
04223000	0.483	0.037	0.980	0.614	0.432	0.490
05244000	0.233	0.011	0.192	0.900	0.424	0.383
05280000	0.148	0.053	1.841	0.776	0.370	0.219
05320500	0.144	0.055	1.683	0.627	0.364	0.506
05408000	0.267	0.009	0.108	0.718	0.368	0.586
05410490	0.291	0.010	0.102	0.811	0.362	0.356
05412500	0.220	0.030	1.298	0.632	0.350	0.417
05418500	0.221	0.021	3.038	0.684	0.341	0.546
05435500	0.249	0.019	2.393	0.742	0.349	0.489
05440000	0.211	0.027	2.862	0.685	0.354	0.402
05447500	0.200	0.038	3.819	0.713	0.312	0.447
05451500	0.178	0.043	3.281	0.661	0.335	0.410
05452000	0.200	0.043	2.003	0.527	0.319	0.506
05454500	0.179	0.042	3.727	0.710	0.334	0.404
05455500	0.185	0.058	2.701	0.507	0.307	0.520
05458500	0.171	0.025	1.043	0.644	0.366	0.470
05471500	0.164	0.054	2.449	0.666	0.315	0.352
05472500	0.163	0.055	2.369	0.556	0.307	0.287
05476500	0.089	0.055	1.805	0.732	0.333	0.336
05479000	0.133	0.060	2.006	0.680	0.340	0.499
05481000	0.162	0.058	2.346	0.584	0.335	0.599
05482500	0.164	0.055	1.364	0.642	0.312	0.476
05484500	0.172	0.047	1.172	0.648	0.307	0.482
05508000	0.189	0.057	2.155	0.392	0.249	0.540
05514500	0.183	0.061	1.299	0.365	0.233	0.385
05515500	0.422	0.013	1.618	0.897	0.383	0.518
05517000	0.358	0.024	2.128	0.755	0.360	0.354
05517500	0.351	0.019	2.073	0.864	0.368	0.440
05518000	0.355	0.019	1.682	0.874	0.363	0.498
05520500	0.340	0.023	1.905	0.859	0.358	0.396
05526000	0.303	0.051	1.750	0.616	0.318	0.503
05542000	0.276	0.083	1.698	0.510	0.298	0.488
05554500	0.246	0.068	2.496	0.563	0.288	0.514
05569500	0.234	0.050	2.596	0.567	0.303	0.519
05570000	0.228	0.048	2.674	0.580	0.302	0.435

05582000	0.215	0.042	1.849	0.685	0.280	0.437
05584500	0.179	0.055	0.938	0.483	0.277	0.456
05594000	0.223	0.060	3.070	0.439	0.212	0.395
06480000	0.021	0.044	3.340	0.687	0.339	0.434
06600500	0.127	0.037	1.610	0.561	0.316	0.449
06606600	0.131	0.043	0.816	0.705	0.331	0.533
06607200	0.160	0.034	1.485	0.609	0.316	0.398
06609500	0.162	0.036	1.932	0.560	0.307	0.402
06799500	0.097	0.018	1.425	0.591	0.293	0.323
06808500	0.168	0.034	1.246	0.596	0.294	0.361
06810000	0.156	0.035	1.321	0.642	0.290	0.358
06811500	0.174	0.029	1.767	0.441	0.264	0.382
06813000	0.166	0.042	1.759	0.549	0.262	0.443
06815000	0.197	0.032	2.166	0.435	0.233	0.520
06817000	0.148	0.043	2.477	0.527	0.281	0.443
06860000	0.018	0.053	2.931	0.433	0.230	0.421
06869500	0.080	0.030	2.162	0.556	0.224	0.419
06883000	0.080	0.004	1.205	0.608	0.258	0.435
06884400	0.092	0.018	3.507	0.568	0.257	0.460
06885500	0.143	0.052	2.414	0.326	0.233	0.411
06888500	0.168	0.057	2.465	0.593	0.223	0.317
06892000	0.186	0.067	3.145	0.365	0.216	0.358
06894000	0.165	0.058	2.501	0.442	0.193	0.434
06897500	0.163	0.059	2.303	0.410	0.250	0.440
06898000	0.166	0.060	3.109	0.407	0.283	0.463
06899500	0.173	0.054	3.293	0.426	0.263	0.538
06908000	0.182	0.075	1.928	0.379	0.198	0.507
06913500	0.171	0.092	3.070	0.362	0.196	0.537
06914000	0.185	0.104	3.305	0.294	0.179	0.545
06933500	0.303	0.030	1.486	0.666	0.181	0.568
07019000	0.291	0.030	2.107	0.600	0.184	0.412
07029500	0.457	0.042	1.302	0.684	0.068	0.516
07052500	0.300	0.035	2.313	0.642	0.172	0.406
07056000	0.386	0.051	1.902	0.557	0.131	0.479
07057500	0.402	0.015	1.516	0.807	0.160	0.467
07058000	0.299	0.022	1.894	0.715	0.160	0.479
07067000	0.374	0.018	1.080	0.770	0.170	0.476
07068000	0.429	0.015	0.940	0.813	0.169	0.441
07069500	0.363	0.023	1.103	0.729	0.128	0.471
07072000	0.326	0.018	1.624	0.819	0.153	0.530
07074000	0.338	0.035	1.873	0.579	0.110	0.503
07144200	0.106	0.024	1.380	0.457	0.183	0.474

07147070	0.175	0.027	3.308	0.330	0.180	0.510
07147800	0.156	0.054	2.222	0.412	0.168	0.508
07152000	0.125	0.034	2.672	0.397	0.143	0.515
07172000	0.187	0.093	3.087	0.418	0.143	0.494
07177500	0.162	0.070	0.954	0.309	0.124	0.555
07183000	0.177	0.052	3.076	0.479	0.192	0.427
07186000	0.210	0.039	3.905	0.526	0.158	0.459
07196500	0.277	0.032	2.928	0.621	0.119	0.546
07197000	0.285	0.039	2.238	0.578	0.102	0.445
07243500	0.125	0.043	1.342	0.530	0.103	0.533
07252000	0.398	0.065	1.852	0.558	0.111	0.408
07261000	0.474	0.054	2.392	0.530	0.100	0.438
07288500	0.412	0.042	1.365	0.708	0.046	0.476
07290000	0.309	0.056	1.599	0.629	0.038	0.417
07340000	0.402	0.052	1.436	0.511	0.072	0.514
07346070	0.284	0.052	1.462	0.645	0.042	0.542
07348000	0.247	0.066	1.311	0.741	0.042	0.428
07363500	0.342	0.067	1.912	0.628	0.059	0.400
07375500	0.372	0.014	0.995	0.697	0.010	0.383
07378000	0.346	0.025	1.646	0.437	0.009	0.288
07378500	0.320	0.019	2.122	0.565	0.010	0.517
08013500	0.354	0.050	1.609	0.582	0.013	0.465
08032000	0.185	0.047	1.837	0.634	0.040	0.531
08033500	0.166	0.051	1.940	0.714	0.026	0.546
08055500	0.107	0.023	1.514	0.587	0.063	0.462
08095000	0.072	0.064	3.213	0.351	0.054	0.641
08146000	0.045	0.028	1.122	0.417	0.043	0.592
08150000	0.052	0.025	0.945	0.612	0.031	0.582
08167500	0.078	0.034	1.752	0.614	0.033	0.502
08171000	0.127	0.045	2.045	0.606	0.033	0.491
08171300	0.136	0.040	2.262	0.699	0.049	0.514